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UNITED STATES DEPARTMENT OF COMMERCE  
National Telecommunications and  
Information Administration  
Washington, D.C. 20230

May 25, 2001

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FEDERAL COMMUNICATIONS COMMISSION  
OFFICE OF THE SECRETARY

Ms. Magalie Roman Salas  
Secretary  
Federal Communications Commission  
The Portals  
445 Twelfth Street, S.W.  
Washington, DC 20554

Re: Authorization and Use of Software Defined Radios, ET Docket No. 00-47

Dear Ms. Salas:

Enclosed please an original and four (4) copies of the late-filed Reply Comments of the National Telecommunications and Information Administration in the above-referenced proceeding. A disk containing the comments in electronic form is also enclosed. A copy of the comments and a disk have also been provided to the International Transcription Service.

Please direct any questions you may have regarding this letter to the undersigned. Thank you for your cooperation.

Respectfully submitted,

Kathy D. Smith  
Chief Counsel

Enclosures

cc: International Transcription Service

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Before the  
FEDERAL COMMUNICATIONS COMMISSION  
Washington, DC 20554

In the Matter of	)	
	)	
Authorization and Use of Software	)	ET Docket No. 00-47
Defined Radios	)	
	)	

**REPLY COMMENTS OF THE NATIONAL TELECOMMUNICATIONS  
AND INFORMATION ADMINISTRATION**

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May 25, 2001

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**REPLY COMMENTS OF THE NATIONAL TELECOMMUNICATIONS  
AND INFORMATION ADMINISTRATION**

The National Telecommunications and Information Administration (NTIA) respectfully submits the following Reply Comments in response to the Federal Communications Commission’s (Commission) Notice of Proposed Rulemaking (NPRM) in the above-captioned proceeding.<sup>1</sup> Specifically, NTIA addresses comments concerning the definition of Software Defined Radio (SDR), the testing of all combinations of SDR hardware and software, SDR software modification authentication and security protocols, SDR electronic labeling system, Class III permissive changes, software changes by third parties, the certification of SDRs by Telecommunications Certification Bodies (TCB), algorithm-driven technologies, and consideration of receivers in future SDR proceedings.

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<sup>1</sup> *Authorization and Use of Software Defined Radios, Notice of Proposed Rulemaking*, ET Dkt. No. 00-47, FCC 00430 (rel. Dec. 8, 2000) (hereinafter “SDR NPRM”).

**I. THE DEFINITION OF SDR SHOULD BE REVISED TO INCLUDE BOTH THE TRANSMITTER AND RECEIVER AND SIGNAL PROCESSES THAT AFFECT UNDESIRE EMISSIONS.**

In the SDR NPRM the Commission proposed a definition to describe those devices that are eligible for regulatory treatment as SDRs.<sup>2</sup> NTIA supports the general approach of the Commission's proposed definition. The proposed definition of SDR focuses on the ability of software to affect regulated equipment parameters as a new technology that differentiates SDR from ordinary radios, and to recognize that the definition is solely for regulatory purposes. However, NTIA has identified several areas where revisions are necessary to the definition of SDR to adequately describe this new technology.

The proposed definition emphasizes frequency, modulation, and output power as the parameters that can be altered by software in an SDR. All of these parameters affect the desired emissions of the SDR. Several commenters suggested changes to this definition.<sup>3</sup> One commenter proposed that the definition of SDR be revised to recognize software changes which affect both desired and undesired emissions, and to permit hardware changes that do not affect either desired or undesired emissions.<sup>4</sup> In the comments submitted in response to the SDR Notice of Inquiry (NOI), NTIA expressed concern regarding signal processes that are unique to

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<sup>2</sup> *Id.* at ¶ 21.

<sup>3</sup> Comments of Motorola (Motorola Comments), ET Dkt. No. 00-47, (March 19, 2001) at 5; Comments of the Federal Law Enforcement Wireless Users Group, ET Dkt. No. 00-47 (March 19, 2001) at 4; Comments of HYPRES Inc., (HYPRES Comments), ET Dkt. No. 00-47 (March 15, 2001) at 7.

<sup>4</sup> Motorola Comments at 5.

the digitization process in an SDR transmitter which may contribute to signal distortions.<sup>5</sup> Examples include the extraneous spectral emissions that are created by the digital-to-analog conversion (DAC) process and harmonics that are generated by the DAC update rates that are an integer multiple of the signal frequency.<sup>6</sup> It is not known at this time what impacts these digitization effects will have on electromagnetic compatibility (EMC) with other systems in the environment. NTIA, through its spectrum certification process, is working with the Federal agencies to address concerns related to unintended effects of the SDR digitization process and its impact on EMC. NTIA believes that new software changes that can affect undesired emissions are as much of a concern as software changes that affect desired emissions. NTIA supports the commenter's proposal and recommends that the definition of SDR be revised to include signal processes that effect undesired emissions.

The proposed definition of SDR addresses exclusively the parameters associated with the transmitter and excludes the receiver. The operation, management, reconfiguration, and software control of SDR equipment and networks will inherently include both the transmitter and receiver since it must operate as a fully integrated system. In comments submitted by NTIA it was stated that receiver immunity requirements are an extremely important factor in mitigating interference, and the development of industry requirements for receivers could be employed to reduce the potential for interference from adjacent band transmitters.<sup>7</sup> As an initial step, NTIA recommends

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<sup>5</sup> Comments of the National Telecommunications and Information Administration, ET Dkt. No. 00-47, (June 16, 2000) at 21.

<sup>6</sup> *Id.* at 22.

<sup>7</sup> Comments of the National Telecommunications and Information Administration (NTIA SDR NPRM Comments), ET Dkt. No. 00-47, (March 21, 2001) at 8.

that the proposed definition be modified to clearly indicate that the SDR includes both the transmitter and receiver.

Several commenters identified an inconsistency between the definition of SDR contained in paragraph 21 and that contained in the proposed rules in Appendix A of the SDR NPRM.<sup>8</sup> In the Commission's proposed definition contained in paragraph 21, the word "or" is used between the phrases "modulation type" and "maximum radiated," while in Appendix A the word "and" is used between the two phrases. NTIA believes that the use of the word "and" implies that all three parameters must be able to be modified by a software change. NTIA believes that since a change to any one parameter could affect compatibility with other spectrum users, the word "and" should be changed to "or" in the definition of SDR contained in the proposed rules in Appendix A (§ 2.1 (c)).

NTIA proposes the following revised definition of SDR which reflects the points identified in the preceding paragraphs:

*A software defined radio is a radio that includes a transmitter and any associated receiver in which the regulated operating parameters, including the frequency range, modulation type, or maximum output power (radiated or conducted), or other signal processes that affect undesired emissions can be altered by making post-manufacture changes in software. (For the purpose of this definition, software includes any information that can be installed in the radio for the purpose of controlling the radio frequency operation of a programmable or reconfigurable device.)*

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<sup>8</sup> HYPRES Comments at 7; Comments of the Software Defined Radio Forum (SDR Forum Comments), ET Dkt. No. 00-47, (March 19, 2001) at 4.

## **II. TESTING OF EACH HARDWARE AND SOFTWARE COMBINATION AS PART OF THE EQUIPMENT APPROVAL PROCESS DURING THE INITIAL STAGE OF SDR TECHNOLOGY DEVELOPMENT.**

All of the commenters in this proceeding agree with the Commission's proposal that each combination of SDR hardware and software must be tested together as part of the equipment approval process. NTIA shares the views of many of the commenters that approving each combination of hardware and software is necessary at this time because SDR technology has not matured to the point where it is possible to predict the relevant radio frequency (RF) characteristics by examining just the hardware or software.<sup>9</sup>

NTIA agrees with the observations of one commenter that, if SDR is successful, the number of required tests could grow rapidly and become extremely burdensome to both manufacturers and the Commission.<sup>10</sup> To address this problem, the commenter proposes an optional approach that would separate SDR software into two regulatory categories referred to as platform software and signal processing software. Platform software would provide standard interfaces to the radio hardware and manages aspects of radio operation common to all waveforms. Testing of the platform software and the hardware could characterize most aspects of an SDR's performance. Signal processing software implements the signal processing that controls the underlying platform's communications according to a particular standard.<sup>11</sup> The commenter contends that this approach would require that only the signal-processing software

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<sup>9</sup> Comments of Vanu Inc. (Vanu Comments), ET Dkt. No. 00-47, (March 19, 2001) at 5; SDR Forum Comments at 3; Motorola Comments at 6; HYPRES Comments at 6.

<sup>10</sup> Vanu Comments at 7.

<sup>11</sup> *Id.* at 5.



needs to be tested on a single SDR platform, which would avoid the burden of testing every combination as part of the equipment approval process.<sup>12</sup>

The software architecture proposed by the commenter has similarities with the Department of Defense Joint Tactical Radio System (JTRS) architecture, which will be implemented in the first generation of military SDRs.<sup>13</sup> Although promising, NTIA believes that the benefits of the concept proposed by the commenter have not been adequately tested and proven to warrant adoption by the Commission in this initial set of rule changes to accommodate SDR. NTIA recognizes the concern raised by the commenter that testing each hardware and software combination could become burdensome, and is working with the Federal agencies that are developing SDRs to address this potential problem. NTIA urges the Commission to recognize the likelihood of this situation occurring, and to continue to review developments in SDR technology and possibly consider other alternatives for equipment approval as part of future rulemakings, with the understanding that it will remain essential to protect other users of the spectrum.

### **III. SDR AUTHENTICATION AND SECURITY PROTOCOLS FOR SOFTWARE MODIFICATIONS THAT ARE DEVELOPED IN A JOINT INDUSTRY FORUM WILL PROVIDE THE GREATEST BENEFIT TO THE PUBLIC.**

Several commenters addressed the issue of authentication and security for software modifications.<sup>14</sup> The commenters acknowledge the need for ensuring that software is

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<sup>12</sup> *Id.* at 12.

<sup>13</sup> Additional information on the Joint Tactical Radio System project is available at their website <http://www.jtrs.sarda.army.mil>.

<sup>14</sup> Comments of AIRNET Communications Corporation (AIRNET Comments), ET Dkt. No. 00-47, (March 19, 2001) at 6; HYPRES Comments at 11; Motorola Comments at 18.

downloaded and modified safely and securely, however, they believe that it is not necessary for the Commission to develop detailed rules defining the security method to be used.<sup>15</sup> The commenters also state that security is ultimately the responsibility of the equipment manufacturer and that market forces will develop solutions that balance security and innovation.<sup>16</sup> Commenters also provided details about the present status and direction of ongoing industry activities relating to SDR equipment and services.<sup>17</sup>

NTIA continues to believe that the flexibility of SDR to modify operating frequencies, power levels, or modulation schemes requires a cautious approach, and mandates the need to avoid unauthorized modifications to software that could affect the compliance of an SDR. In addition it is noted that none of the commenters addressed in detail the threat of malicious attacks such as hacker attacks or denial-of-service attacks on SDRs, which will not be unlike the open Internet network if remote reconfiguration via software downloads becomes common practice. NTIA believes that this type of activity could present as much a threat to SDR users as intentional or inadvertent unauthorized modification of an approved SDR, and should be adequately protected against in future rules and security protocols.

Several commenters have discussed the multiple ongoing activities and initiatives, such as Wireless Applications Protocol (WAP)<sup>18</sup> and Mobile Station Application Execution

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<sup>15</sup> Comments of the NORTEL Networks Inc. (NORTEL Comments), ET Dkt. No. 00-47, (March 19, 2001) at 8; SDR Forum Comments at 9.

<sup>16</sup> Comments of INTEL Corporation (INTEL Comments), ET Dkt. No. 00-47, (March 19, 2001) at 7; Motorola Comments at 18.

<sup>17</sup> Motorola Comments at 19; SDR Forum Comments at 8.

<sup>18</sup> Wireless Applications Protocol is the worldwide standard for providing Internet communications and advanced telephony services on digital mobile phones, pagers, personal

Environment (MExE),<sup>19</sup> that are working on relevant security and safeguard provisions for users of wireless technology, and have broad participation from all sectors of the industry, including many of the manufacturers.<sup>20</sup> These standards use Public Key Cryptography (PKC) as the basic security mechanism. By using these standards as the foundation for SDR security, NTIA believes the cost impact of security can be minimized, if authentication and security protocols for SDR are developed in a joint industry forum, rather than on a proprietary, manufacturer-decided basis.

#### **IV. CLARIFICATION IS NECESSARY REGARDING THE INFORMATION TO BE INCLUDED IN THE ELECTRONIC LABELING SYSTEM INSTALLED IN SDR EQUIPMENT.**

Several commenters addressed the issue of electronic labeling for SDR equipment. One commenter encouraged the Commission to provide flexibility in the methods of electronic labeling.<sup>21</sup> Another commenter supports the concept of optional electronic labeling for SDR equipment.<sup>22</sup> However, the commenters fail to address the key issue of what type of information should be included in the electronic label.

SDR and the introduction of software programmable radio equipment will change one of the fundamental features of spectrum management; that is the ability to identify a device and

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digital assistants and other wireless terminals.

<sup>19</sup> Mobile Station Application Execution Environment is a wireless protocol that is designed to be incorporated into smart mobile phones. The aim is to provide a comprehensive and standardized environment on mobile phones for executing operator or service provider specific applications.

<sup>20</sup> SDR Forum Comments at 10; Motorola Comments at 24.

<sup>21</sup> AIRNET Comments at 5; NORTEL Comments at 7.

<sup>22</sup> Motorola Comments at 15.

easily determine its RF characteristics, certification record, and authorized modifications. Currently each device is carefully identified with a unique Commission identification number referenced to relatively static applications, test results, and databases, which have allowed potential buyers and regulatory agencies to identify a specific device. NTIA believes that the need for this information still exists, and may even become more critical as wireless applications move toward global application. NTIA recognizes that the ability to reconfigure an SDR easily using a software download drastically changes this fundamental feature of spectrum management and agrees with the Commission on the need to consider alternatives for the equipment identification system of the future. NTIA also agrees with the commenters that electronic labeling of equipment may play a major role in such a system.

NTIA notes that the rules proposed by the Commission in § 2.925(e) of the SDR NPRM only require that the optional electronic label provide the same information as the current physical identification label.<sup>23</sup> Since authorized emissions are not required on the current identification label, NTIA believes that it is not clear what the Commission desires the manufacturer to include within the database and electronic labeling systems installed in the SDR equipment. NTIA recommends that if it is the intention that authorized emissions and/or other regulated RF parameters should be stored and made available by the display, that the Commission should clarify this in the final rules.

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<sup>23</sup> SDR NPRM at Appendix A.

**V. AT THIS TIME THE CLASS III PERMISSIVE CHANGE SHOULD BE LIMITED TO SOFTWARE MODIFICATIONS.**

The Commission requested comments on whether the proposed Class III permissive change should be limited to only software changes.<sup>24</sup> Several commenters support limiting this new class of permissive change to software only.<sup>25</sup> Other commenters recommend that the new class of permissive change should not be limited to software only.<sup>26</sup> At this point in the development of SDR technology, NTIA agrees with the commenters that believe the Class III permissive change should be limited to software changes. NTIA believes limiting the changes to software only is necessary until the Commission has gained enough experience with this new class of permissive change.

One commenter observed that the software-only restriction seems to preclude hardware upgrades such as increases in processor memory that might be coincident with software upgrades.<sup>27</sup> NTIA believes that this type of non-RF change to a device is allowed as a Class I permissive change permitted under the existing provision of the rules. NTIA urges that the Commission clarify this point.

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<sup>24</sup> SDR NPRM at ¶ 28.

<sup>25</sup> Comments of Cingular Wireless LLC, ET Dkt. No. 00-47, (March 19, 2001) at 5; Comments of Elite Electronic Engineering Company, ET Dkt. No. 00-47, (March 19, 2001) at 2; AIRNET Comments at 4; HYPRES Comments at 9.

<sup>26</sup> Motorola Comments at ii; NORTEL Comments at 6; SDR Forum Comments at 6.

<sup>27</sup> Motorola Comments at 9.

**VI. A JOINT AUTHORIZATION PROCEDURE SHOULD BE ESTABLISHED FOR ALL THIRD PARTY SDR SOFTWARE CHANGES.**

In the SDR NPRM, the Commission proposed that only the grantee of the authorization for an SDR may file for a Class III permissive change.<sup>28</sup> Several commenters expressed support for this proposal,<sup>29</sup> while other commenters opposed it.<sup>30</sup> Commenters also recommended that a third party be authorized to file for a Class III permissive change if authorized to do so by the manufacturer.<sup>31</sup> One commenter presented several third party software scenarios to illustrate administrative problems encountered in applying the rules as proposed by the Commission.<sup>32</sup> NTIA agrees with this commenter that when the original grantee and third parties make changes independently, the proposed rules may not adequately regulate all possible hardware and software combinations.<sup>33</sup> The commenter recommends that third parties and the original grantee be jointly accountable, through a joint authorization, for the safe and reliable operations of the hardware and software combinations.<sup>34</sup> Since the JTRS architecture expects to make significant use of third party software, the administrative scenarios and problems described by the commenter are thought to be realistic and could affect JTRS use of commercial waveforms.

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<sup>28</sup> SDR NPRM at ¶ 26.

<sup>29</sup> Comments of AT&T Wireless Services, ET Dkt. No. 00-47, (March 19, 2001) at 2; AIRNET Comments at 4.

<sup>30</sup> HYPRES Comments at 8; INTEL Comments at 6; NORTEL Comments at 5; SDR Forum Comments at 6.

<sup>31</sup> Elite Comments at 2; Motorola Comments at 18.

<sup>32</sup> Motorola Comments at 16.

<sup>33</sup> *Id.* at 18.

<sup>34</sup> *Id.*

NTIA believes that the proposal of instituting some type of joint authorization for third party software changes has merit and would help to ensure that no unauthorized modifications are made to SDR equipment.

In addition to instituting a joint authorization between the original grantee and any third party, the Commission should also consider assigning unique identifiers to each software based waveform application, as well as the Commission's identification to the original SDR hardware platform. This is similar to an approach proposed by one of the commenters, whereby the software includes an encrypted software tag that specifies the limits set out in the corresponding technical rules. The hardware would then reject transmission requests that exceed those limits.<sup>35</sup> NTIA believes that such an encrypted tag that can be used to protect the SDR against unauthorized software can also protect the operating parameters of the SDR against unauthorized modification.

**VII. NTIA REITERATES SUPPORT FOR THE ESTABLISHMENT OF A SUFFICIENT TIME PERIOD BEFORE A TCB CAN CERTIFY OR GRANT PERMISSIVE CHANGES FOR SDR EQUIPMENT.**

In the comments submitted in response to the SDR NPRM, NTIA recommended that the Commission establish a period of two years after the effective date of the final rules, before TCBs should be permitted to certify SDR equipment.<sup>36</sup> Several commenters indicated similar concerns to those raised by NTIA and also supported establishing a time period before TCBs should be permitted to certify SDR equipment.<sup>37</sup> NTIA believes that establishing such a time

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<sup>35</sup> Vanu Comments at 2.

<sup>36</sup> NTIA SDR NPRM Comments at 6.

<sup>37</sup> AT&T Comments at 6; Elite Comments at 2.

period will allow the Commission to gain experience in reviewing SDR certification applications. There are security issues associated with SDR equipment that are vague and will need to be interpreted by the Commission. Furthermore, given the unique characteristics of SDR equipment, the TCBs will also require training before they can be allowed to certify equipment or grant permissive changes. NTIA continues to believe that the time-frame has to be long enough to ensure that enough SDR variants have been examined by the Commission to verify that the adopted procedures and rules are sufficient.<sup>38</sup> Moreover, establishing a time period of two years should not affect the deployment of SDR technology. Therefore, NTIA reiterates its support for the establishment of a time period after the final rules come into effect before TCBs are allowed to certify or grant permissive changes for SDR equipment and have recommended two years.

#### **VIII. IT IS PREMATURE TO ESTABLISH REGULATORY REQUIREMENTS FOR ALGORITHM-DRIVEN TECHNOLOGIES.**

The capabilities of cognitive-radio<sup>39</sup> have been discussed by the Commission's Technical Advisory Committee's Spectrum Management Focus Group.<sup>40</sup> NTIA agrees with one commenter that algorithm-driven technologies (rules based systems) may someday facilitate sharing the spectrum more efficiently.<sup>41</sup> However as stated in the comments submitted by NTIA in response to the SDR NPRM, there are potentially many new interference scenarios that can be created when you have a mixed environment of radios employing algorithm-driven technologies

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<sup>38</sup> NTIA SDR NPRM Comments at 7.

<sup>39</sup> Cognitive radio is a particular extension of software radio that employs model-based reasoning about users, multimedia content, and communications context.

<sup>40</sup> SDR NPRM at ¶ 32.

<sup>41</sup> SDR Forum Comments at 14.



and legacy systems.<sup>42</sup> NTIA also agrees with the commenter that these algorithm-driven technologies are still under development and not likely to be introduced for commercial use in the near future.<sup>43</sup> Based on these factors, NTIA supports the commenter and the Commission's decision that regulatory consideration of these capabilities are premature and changes to the current spectrum allocation and management policies for SDR are not necessary at this time.

#### **IX. FUTURE RULEMAKING PROCEEDINGS ON SDR SHOULD CONSIDER RECEIVERS.**

The current rulemaking proceeding for authorization and use of SDRs is focused on the regulation of the transmitter and does not address the associated receiver. While responsive to industry and arguably appropriate in an uncongested spectrum environment, this approach could adversely affect the expedient introduction of new technologies and the effective management of spectrum resources. As wireless services continue to rapidly grow and additional spectrum is more difficult to identify, it is increasingly important to manage the resource considering the "total system RF performance" in order to achieve more efficient use of all frequency bands.

The operation, management, re-configuration, and software control of SDR equipment and networks will inherently include both the transmitter and the receiver, since it must operate as a fully integrated system to achieve the potential benefits. For example, commercial radio services, such as cellular and personal communications services (PCS), operate as a single, tightly managed system, including the consumer's handset, through voluntary detailed rules and standards that succeed because of the mutual interest and cooperative action between manufacturers and network operators. However, in other frequency bands it may eventually be

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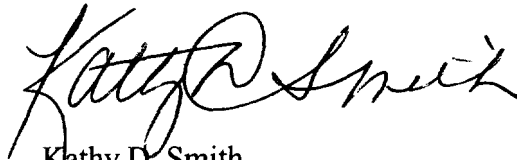
<sup>42</sup> NTIA SDR NPRM Comments at 8.

<sup>43</sup> SDR Forum Comments at 14.

desirable to make receivers part of the future service rules to ensure greater efficiencies, and implement more effective and responsive spectrum management practices. This would, of course, be carried out on a selective basis, not unilaterally or disregarding economic, operational and other valid factors.

Some parties might consider it more appropriate to address receivers only in proceedings addressing the introduction of new radio services (e.g., Fourth Generation (4G) Wireless, Secondary Markets, etc.) that will specifically depend on evolving SDR technologies and capabilities. Ultimately the most effective rulemaking approach may be through a combination of equipment approval regulations and radio service specific regulations. Furthermore, any receiver regulation approach must be tempered by the intended radio service application and the order of complexity of the device. Therefore, NTIA urges the Commission to examine as part of future rulemaking proceedings the development of generally applicable rules for SDR receivers.

Respectfully submitted,



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